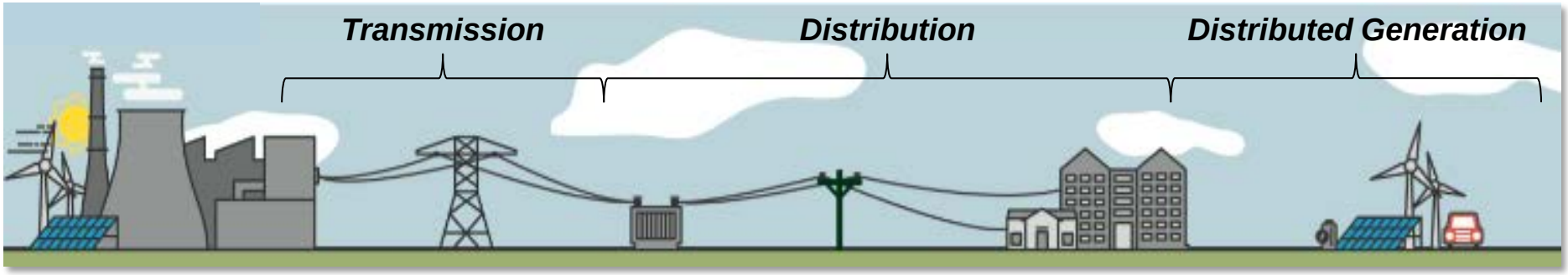
Distribution System Planning Overview MPUC Workshop

November 25, 2014

Agenda

- Session Objectives
- Distribution System Overview
- Introduction to Distribution System Planning
- Modernization
- Q&A

Distribution System – Overview

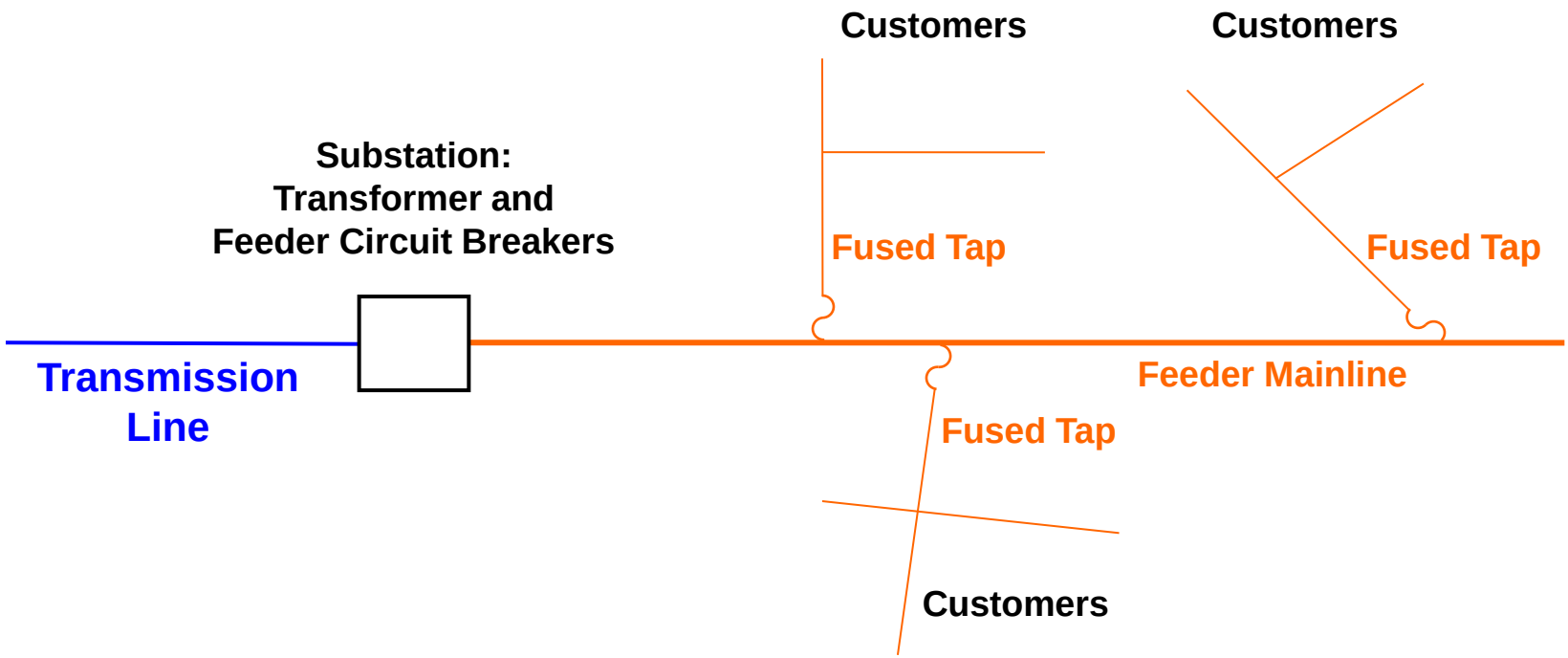


The distribution system serves the end-use customers.

Predominantly 15-35kV.

Distribution System: Basic Design

Schematic of Typical Radial Circuit Design



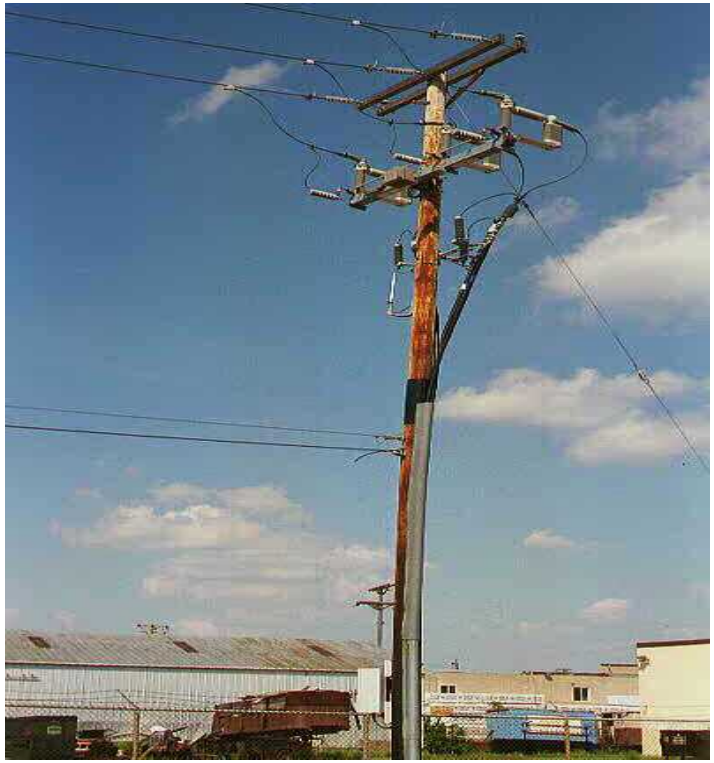
Designed for Safety and Reliability

Distribution Substations

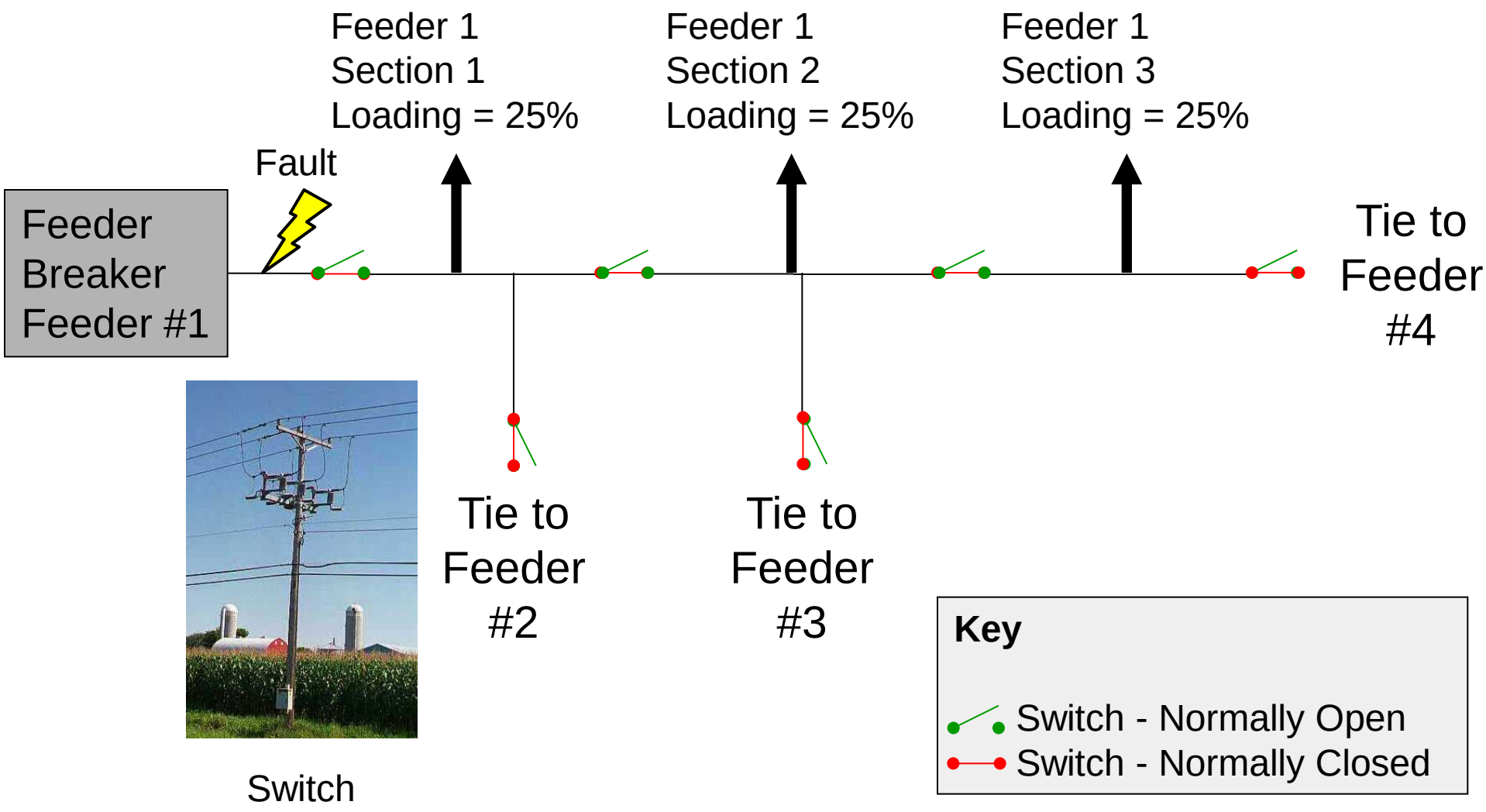
- **Site sized for anticipated load – 1 to 3 transformers at the same voltage**
- **Incremental installation of transformers and feeders planned to meet future load demand**
- **Intro to Contingency Ratings**
- **Higher levels of Distributed Generation (DG) will affect substation capacity, system protection, and voltage regulation**

Distribution Feeder Capacity

- **Feeders are sized to carry existing and planned customer load**
- **Where possible, we design in redundancy**



Reliable Feeder Design

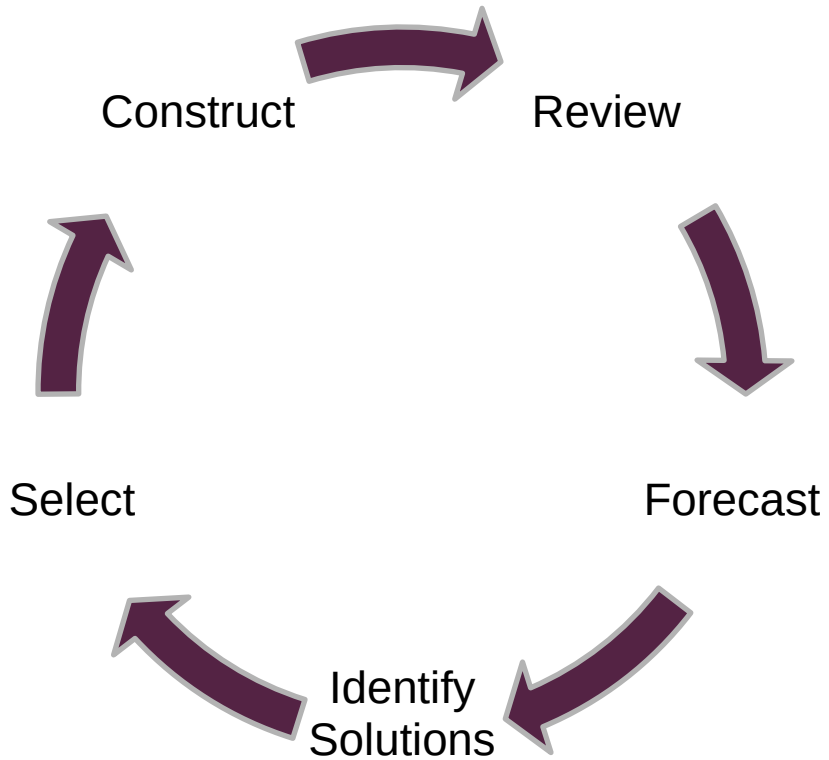


Distribution Feeder Transformers, Secondary & Services

- Service transformers, secondaries, and services connect customers to the distribution system
- The distribution system functions mostly one-way today
- Higher levels of DG mean the distribution system will have to function more often in a two-way mode in the future

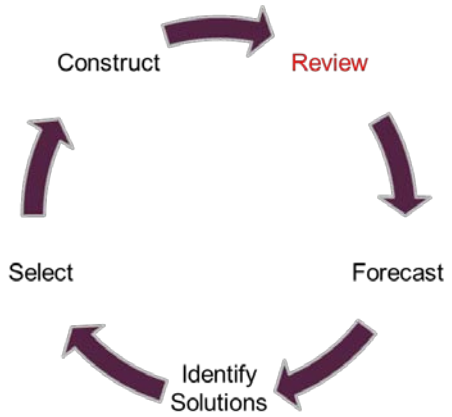
Distribution System Planning Process Overview

Annual Distribution System Planning Process



Review System Status

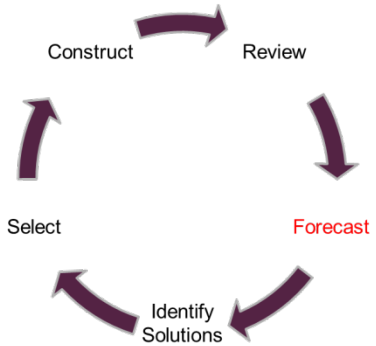
- Feeder and substation reliability performance
- Any condition assessments of equipment
- Current load versus previous forecasts
- Total system load forecasts
- Previous planning studies



Distribution System Planning Begins with a Review of Current Infrastructure & Performance

Load Forecast

- **Load Forecasting is conducted annually for the distribution system**
  - **Feeders**
  - **Substations**
- **Location specific information**
  - **Drivers of load changes**
    - **Customer driven (residential, commercial, industrial)**
    - **New sources of demand (penetration of central air-conditioning, electric vehicles)**
    - **DG applications and projections**
- **Aggregate and compare with system projections**



Loads are Forecast with a High Degree of Granularity – at the Feeder Level

Identify Solutions

Is the problem localized and solution straight forward?

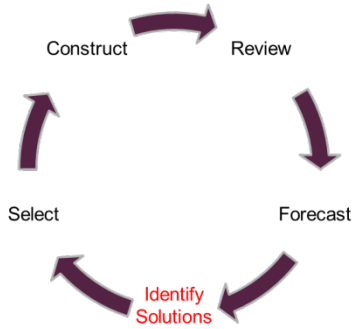
Yes

- Identify the solution
- Quantify the risk
- Estimate costs

No

- Identify the options
- Quantify the risk
- Estimate costs
- Obtain stakeholder input
- Perform planning study
- Select the solution

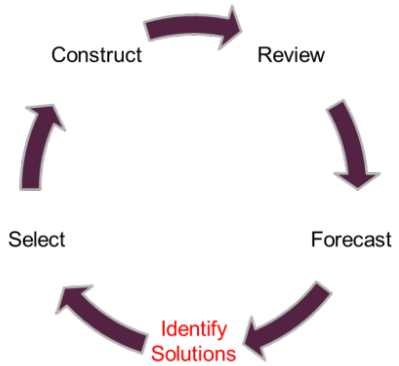
Enter into the budgeting tool



While Many Solutions are Straight-forward, Others Require Detailed Analysis

Perform New Planning Studies

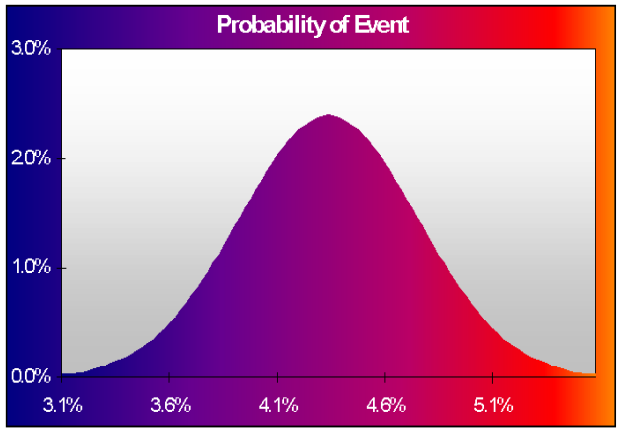
- **Location specific studies are conducted to evaluate various alternatives and determine short and long range plans**
  - **Area load growth (including impact of DG)**
  - **Saturation (limits on load growth)**
  - **Transmission plans**
  - **Economic comparison**
  - **Reliability expectations**



Comprehensive Studies Have Become More Complex with DER

Prioritize and Select Solutions

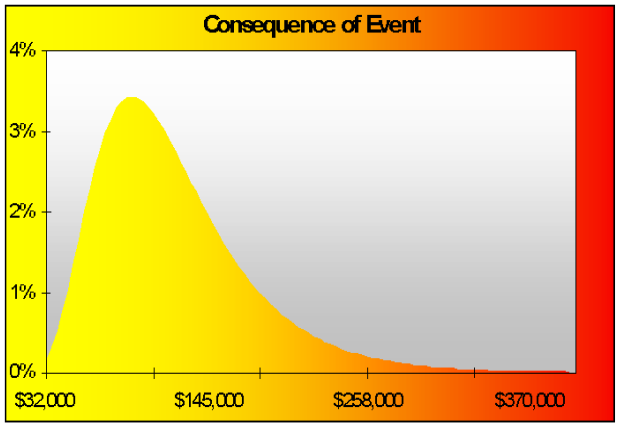
Operational Risk Management



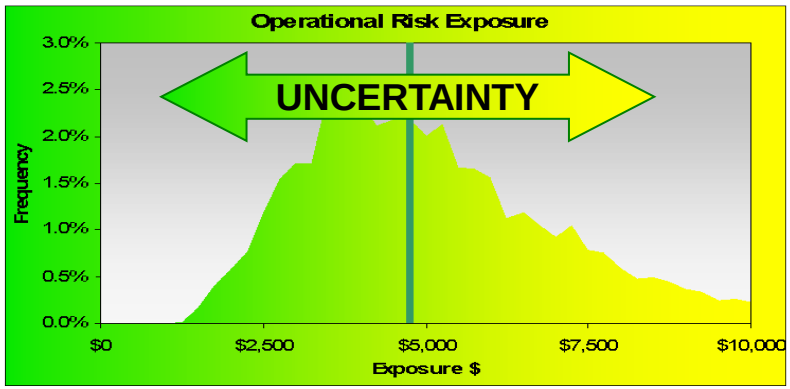
Probability of Event

X

=



Consequence of Event

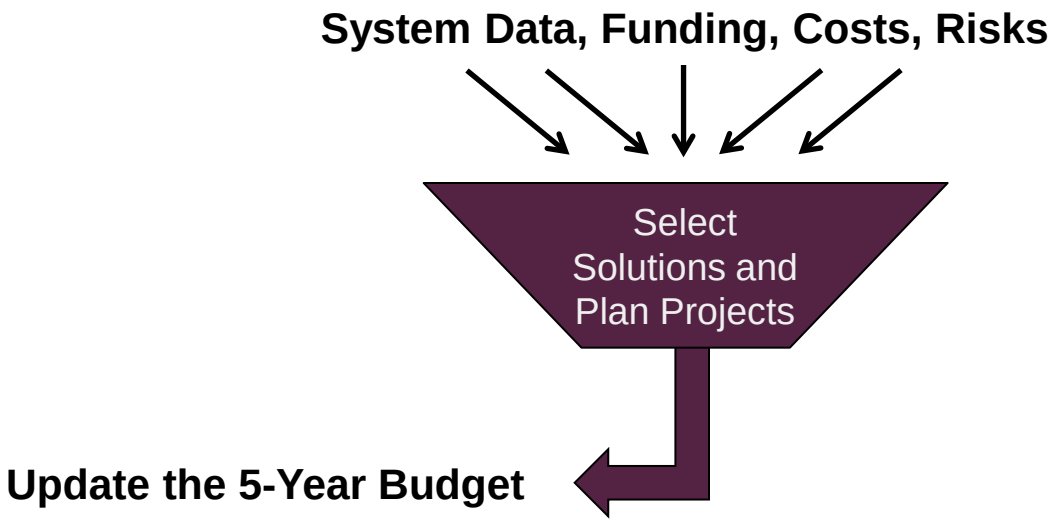


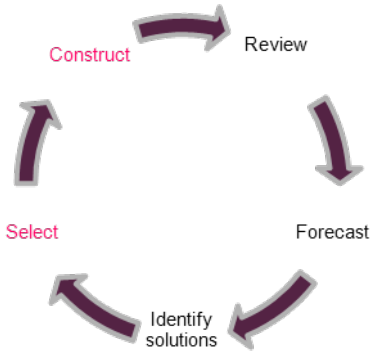
Operational Risk of Event

Risk Can Not be Eliminated. We Want to Provide Our Customer's with Smart Cost-effective Solutions.

Finalize Solution Selection

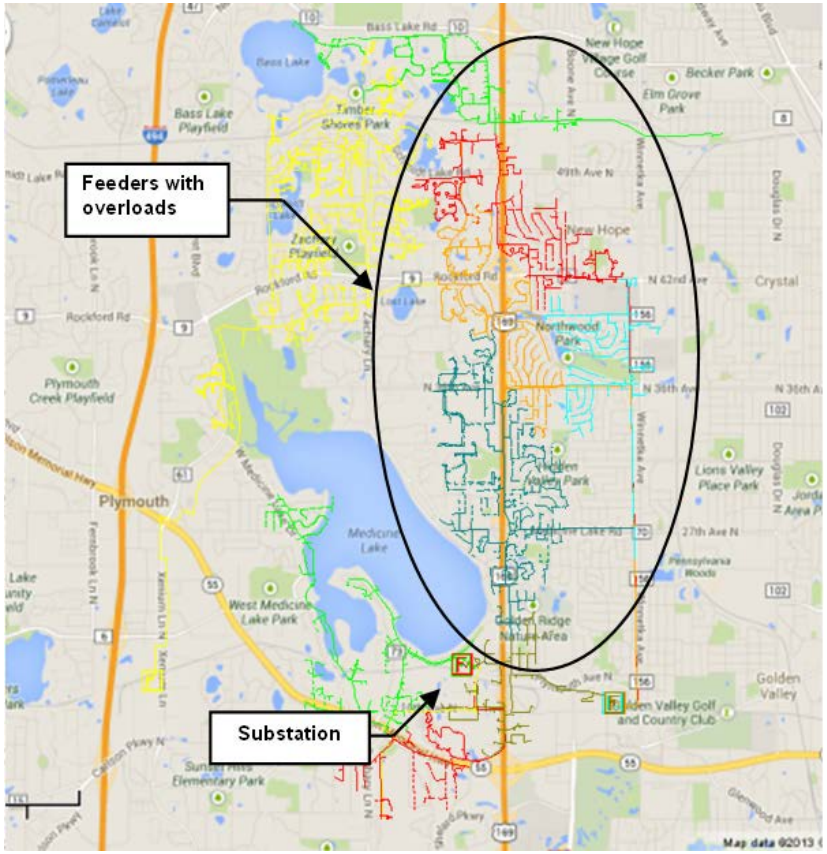
- **Select the solutions**
- **Develop and update 5 year budget**
- **Release projects for construction**



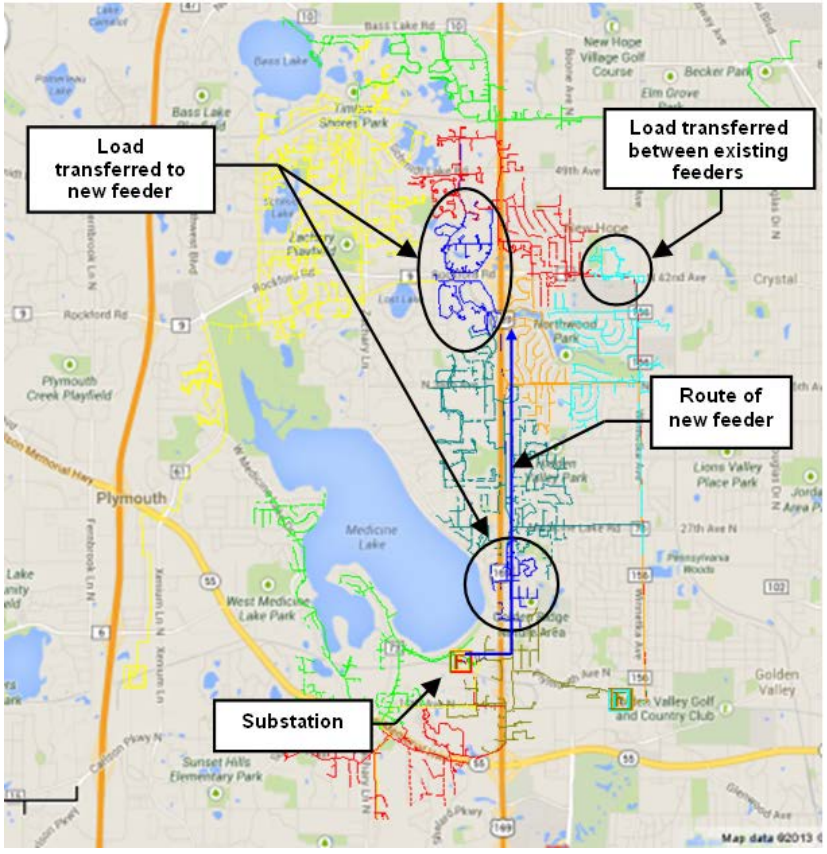


Our Budget is Our Roadmap to Wise Investments that Provide for Our Customer's Needs

Feeder Plan Mitigation Example



BEFORE--Feeders Overloaded (several in circled area)

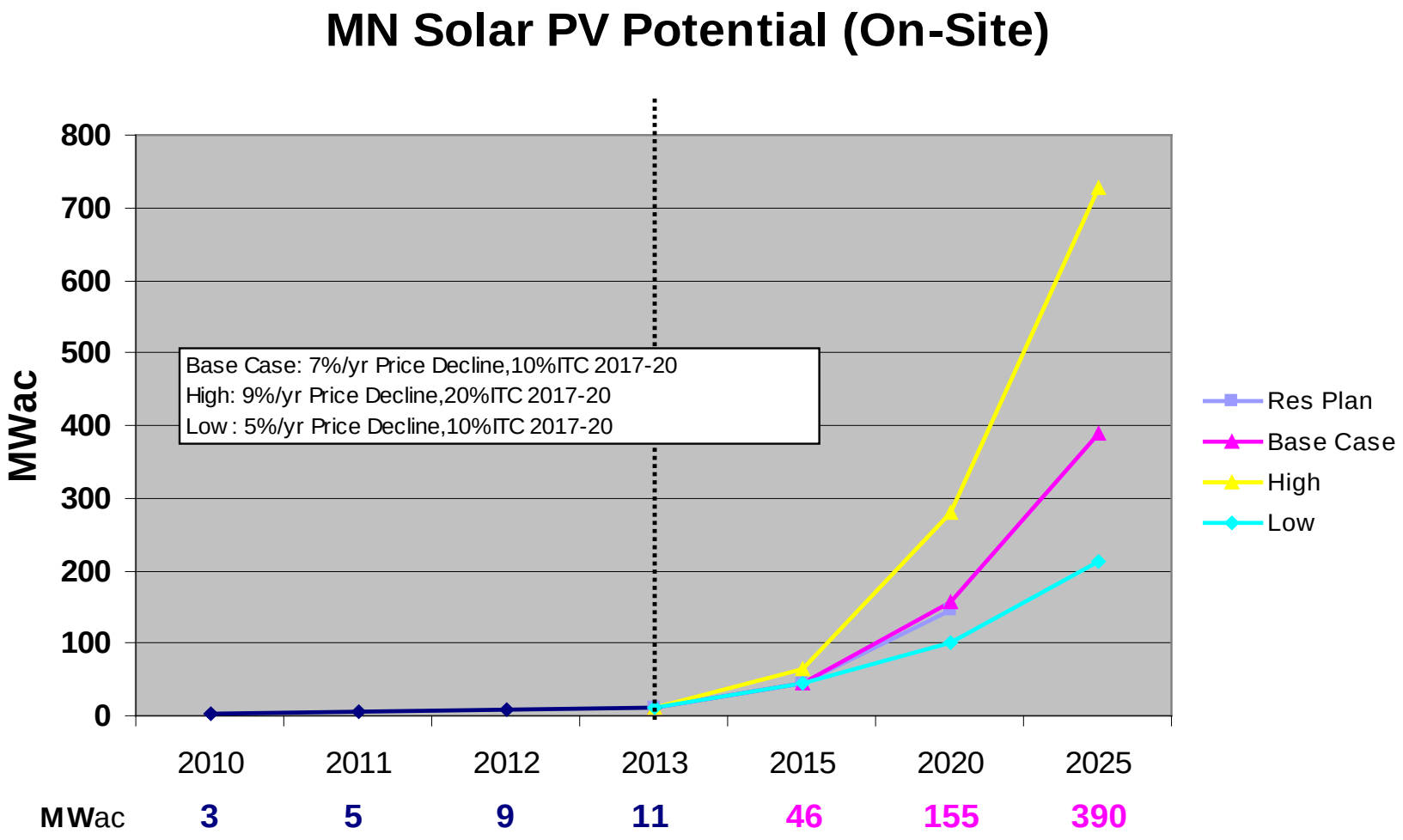


AFTER--New Feeder (blue) relieves overload with transfers (circled areas)

Distribution System Planning for the Future

- **Forecasting quantity and dependability of DG**
- **Forecasting impacts of conservation & load control**
- **Forecasting electric vehicle adoption**
- **Move from “peak only” forecasting to 24/7.**
- **Improve planning & forecasting tools**
- **Consider storage implications**

Forecasting DG – Solar Example



Preparing for a more Intelligent Distribution System

- Distribution System Intelligence (DSI)
  - Advanced Distribution Management System (ADMS)
  - Secure Field Area Network (FAN)
  - Expand SCADA coverage
  - Advanced Field Devices
    - Monitoring & Control Equipment
      - Capacitor Controls
      - Smart inverters
    - Automated field switches (FLISR)
    - Dispatchable Resources (DG, Storage, DER)

Building Blocks

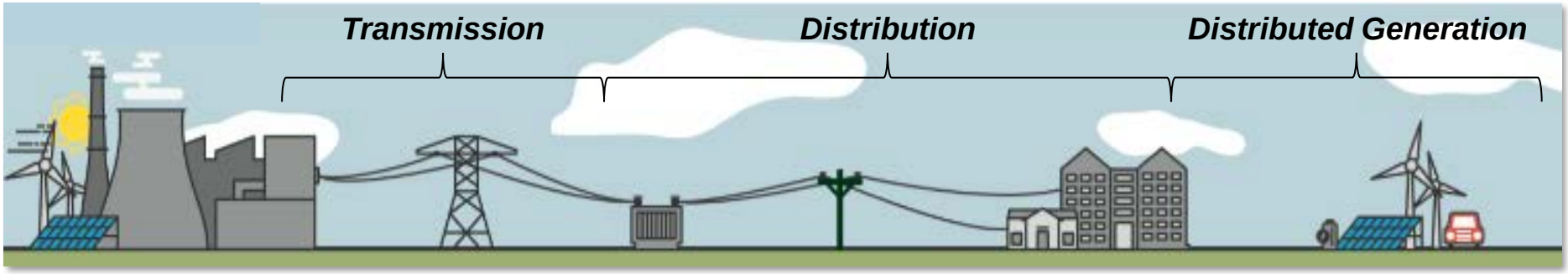
Distribution System Modernization

- **Asset Health Refresh Opportunities**
  - **Capacitor Controls**
  - **Substation RTUs**
  - **Relays**
  - **Regulators**
  - **Conductor**
  - **Network Protectors**

Conclusion

- **We face a challenge of funding capacity needs, asset refreshment, and modernization – finding the right balance**
- **Distribution planning is becoming more complex**
- **The integrated grid of the future will be robust & reliable, serving energy users and producers alike**

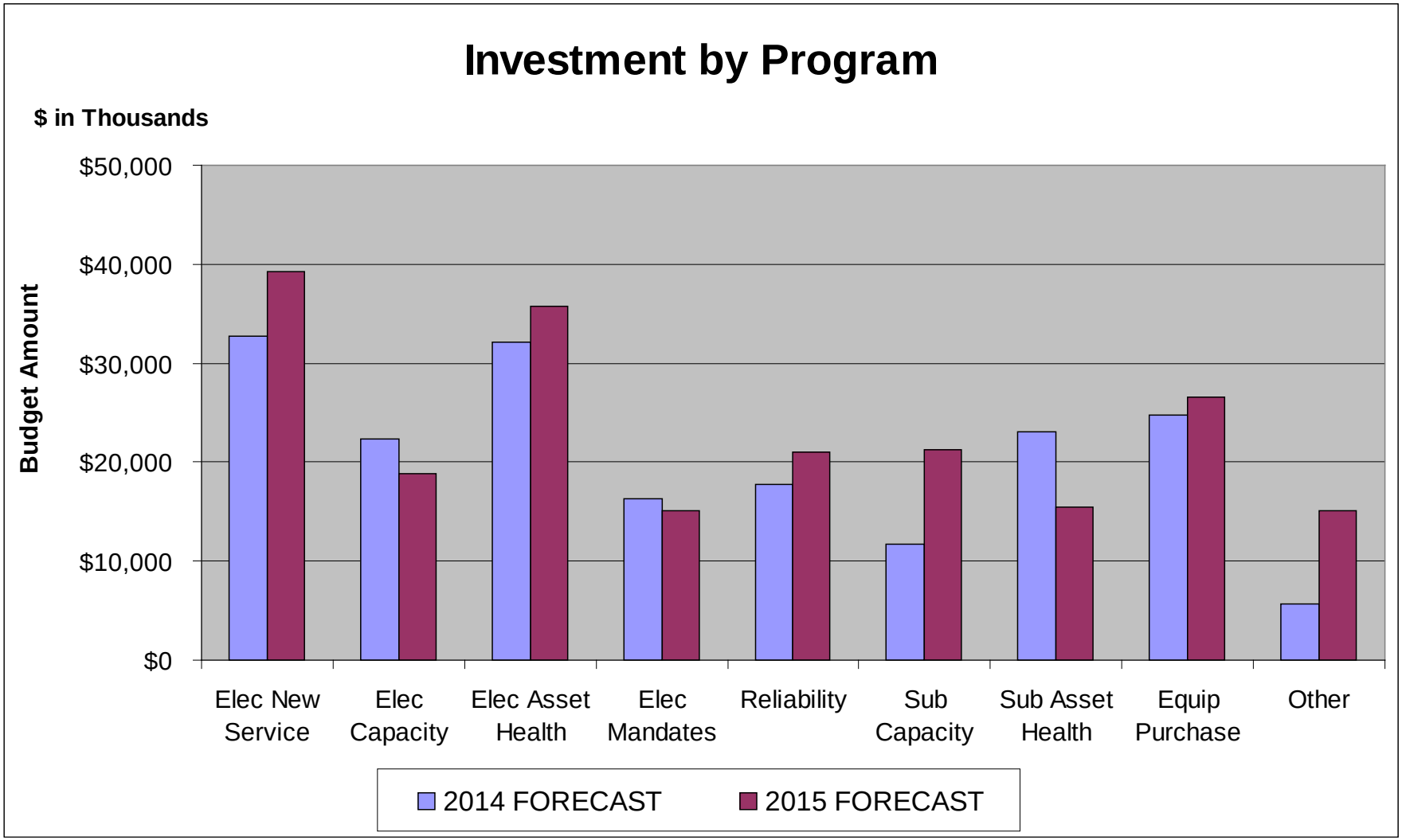
Questions?



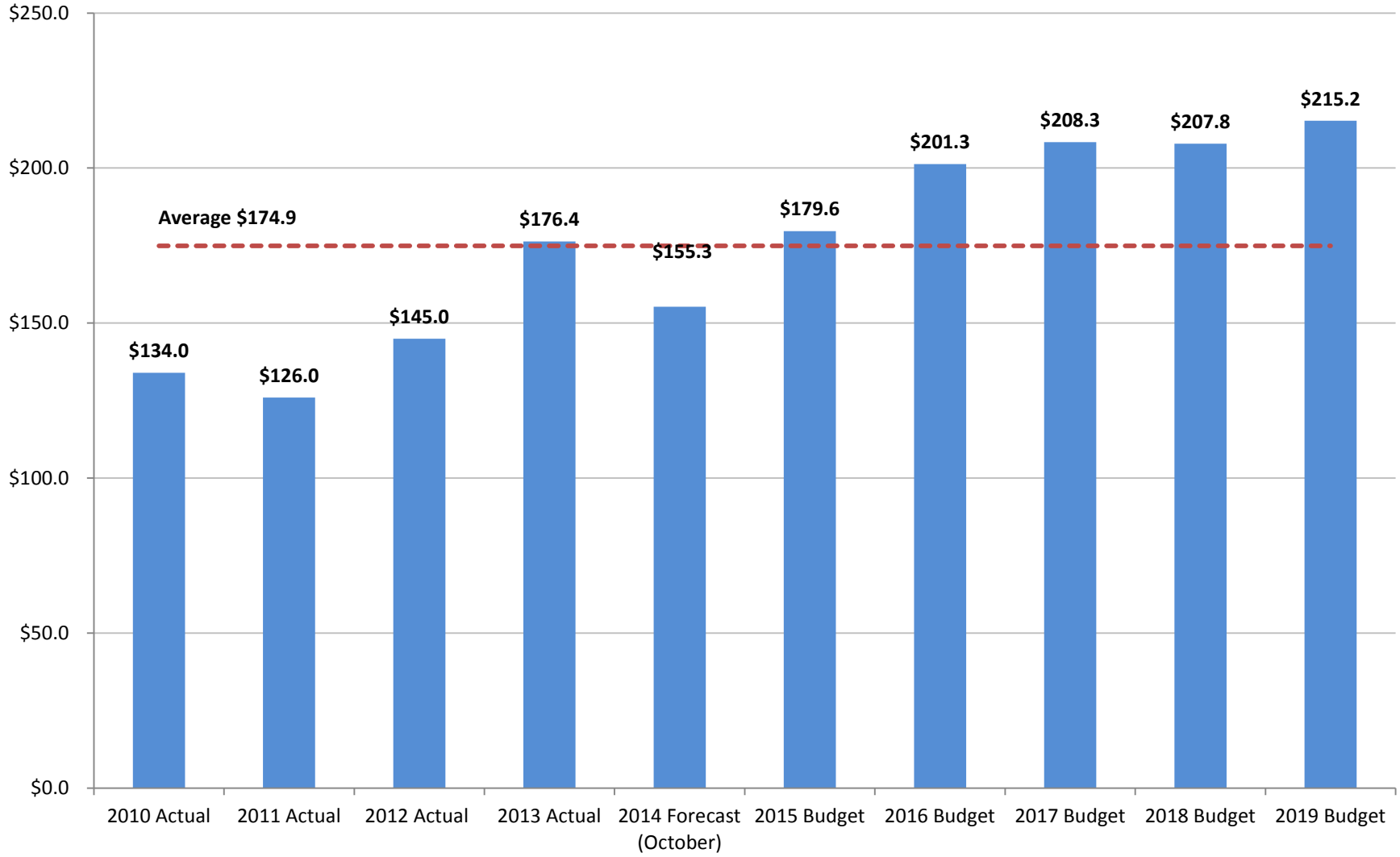
APPENDIX

Project Execution and Monitoring

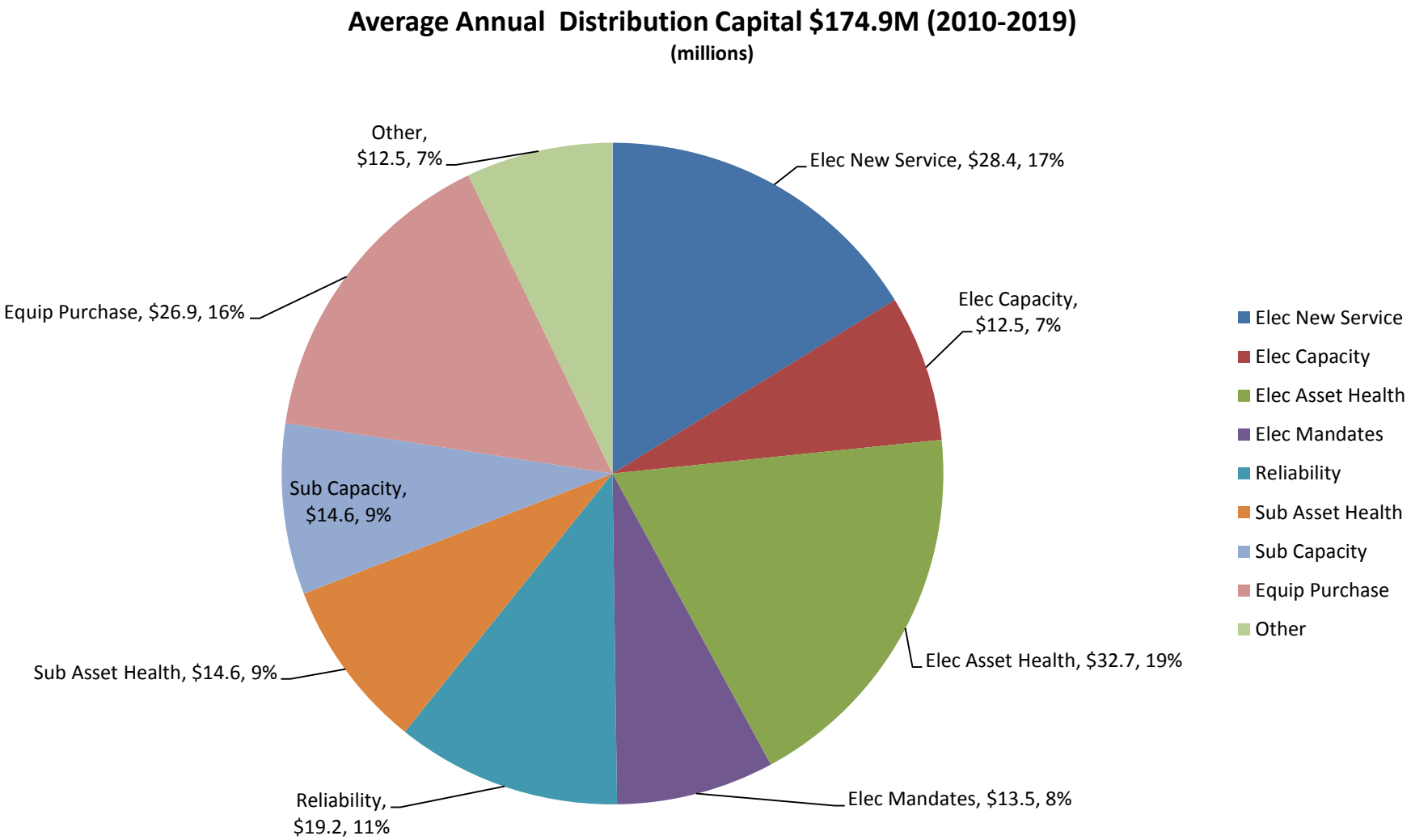
- Investment by budget program for NSPM



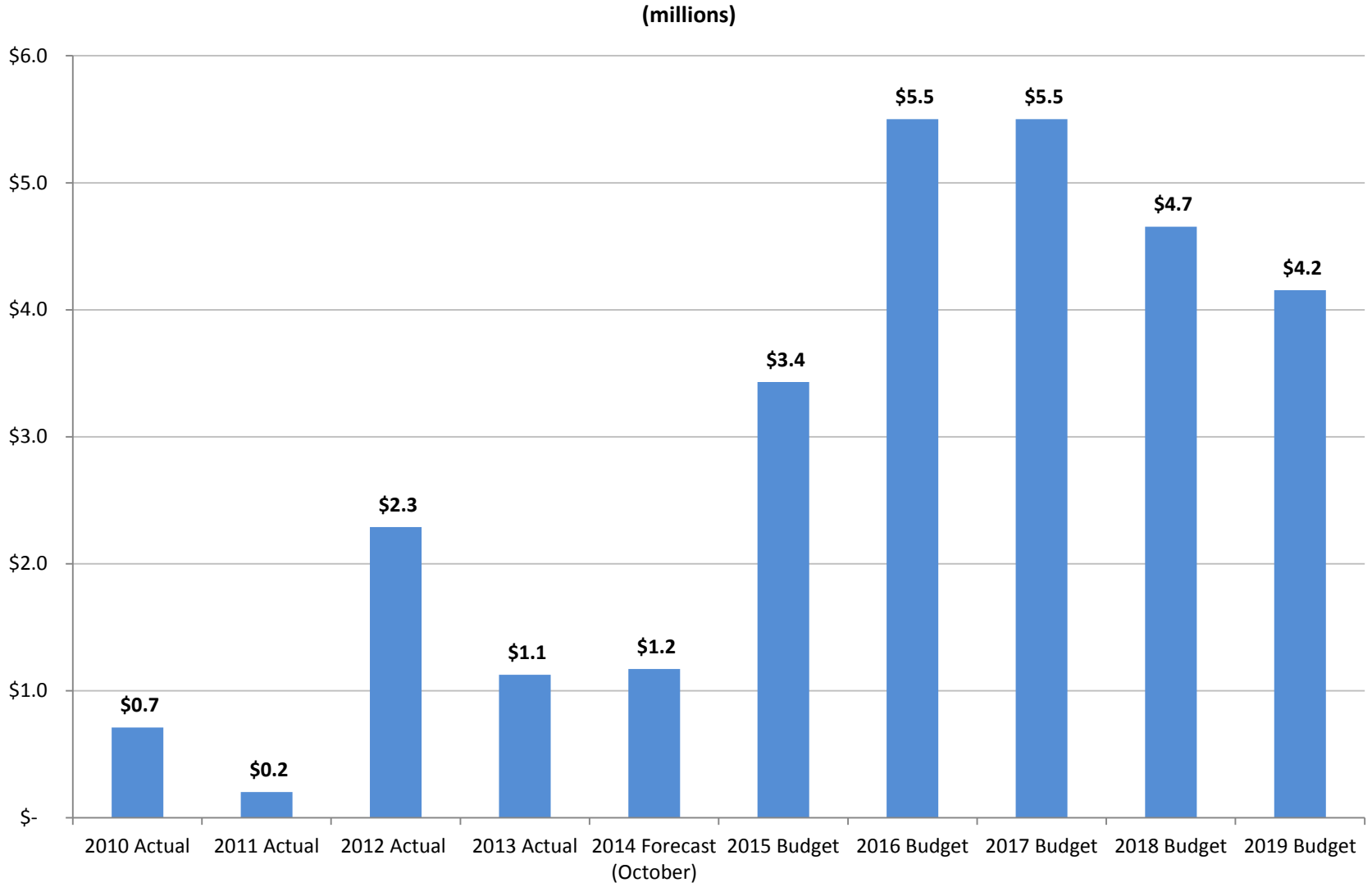
Distribution Capital Budget 2010-2019 (NSPM)



Capital Budget by Program 2010-2019 Averages (NSPM)



Distribution System Intelligence (DSI) Budget 2010-2019 (NSPM)



ACRONYMS AND DEFINITIONS

Abbreviation	Definition
CAIDI	**C**ustomer **A**verage **I**nterruption **D**uration **I**ndex: Measures the average outage duration of an interruption divided by the number of customer interrupted. CAIDI is also equal to SAIDI / SAIFI.
Circuit Breaker	An electromechanical device used to configure the flow of electricity on the distribution grid. A Circuit Breaker is designed to open or close while electricity is flowing through the circuit. When a circuit breaker is open, no electricity is flowing through the circuit
Fault	A condition typically in which a feeder or tap is overloaded creating a risk of fire or explosion
Feeder	Lines connecting distribution substations to taps
Firm	Capacity or generation that can be counted on to be available at all times and ready to serve in backup contingency situations
kVA	Kilo Volt Amps: 1,000 Volt-Amps. A volt is a measure of the force of electricity. An amp (ampere) is a measure of the flow of electricity
MAIFI	**M**omentary **A**verage **I**nterruption **F**requency **I**ndex: Measures the average number of momentary interruptions for the average customer over a given period (usually monthly or annually)
MVA	Mega Volt Amps: 1,000,000 Amps or 1,000 kVA

Abbreviation	Definition
Recloser	A circuit breaker that includes a mechanism to automatically close (reconnect) after a set period of time. Reclosers are used to restore service after a momentary fault
SAIDI	**S**ystem **A**verage **I**nterruption **D**uration **I**ndex: Measures the total duration of an interruption for the average customer for a given period (usually monthly or annually). Lower values are better.
SAIFI	**S**ystem **A**verage **I**nterruption **F**requency **I**ndex: Measures the average number of times a customer is interrupted over a given period (usually monthly or a annually). Lower values are better.
Switch	An electromechanical device used to configure the flow of electricity on the distribution grid. A switch is designed to be opened or closed when electricity is not flowing through the circuit. When a switch is open, no electricity is flowing through the circuit
Tap	Final leg of the distribution system before connecting to customer premises
Transformer	An electromechanical device that converts alternating current to higher or lower voltage